

**INVENTION:** Multi-scale code division frequency/wavelet multiple access

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**WHAT IS CLAIMED IS;**

1. A means for the design of new multi-resolution complex Wavelet waveforms in the Fourier domain and for the design of  
10 new orthogonal Wavelet division multiple access OWDMA filter banks with these Wavelets with properties which

provide a means for the complex extensions of the Wavelet concept to the Fourier frequency domain with the addition of frequency translation as a Wavelet parameter to the existing  
15 scale (dilation) and translation (shift) parameters for Wavelets.

provide a means for the single multi-resolution complex Wavelet design for all of the Wavelets at multiple scales, frequencies, and translations

provide a means for multi-resolution complex Wavelet design  
20 methodologies that circumvent the need to apply the current methodology to use a Wavelet iterated filter bank construction to obtain the Wavelet and the current methodology to generate the Wavelet as a function of the scaling functions and that provide a means for flexibility to meet the application goals

25 provide a means for the design of new orthogonal OWDMA filters and filter banks using multi-resolution complex Wavelet channelization waveforms designed in the Fourier domain and which can include analytical and iterated filter bank construction design techniques

30 provide a means for the design of new orthogonal OWDMA filters and filter banks over contiguous and non-contiguous frequency bands and for simultaneous multi-resolution OWDMA filters at different scales and different frequencies and different symbol rates using multi-resolution complex Wavelet  
35 channelization waveforms designed in the Fourier frequency domain

and which can include analytical and iterated filter bank construction design techniques

provide a means for the design of the mother multi-resolution Wavelet at dc in the Fourier frequency domain and a  
5 means for constructing the desired multi-resolution complex Wavelet from this mother Wavelet using appropriate scale, frequency, and translation changes to the mother Wavelet

2. A means for the design of new multi-scale complex code division multiple access MS-CDMA encoding and decoding over  
10 multiple scales where each scale corresponds to an independent communications parameter and which MS-CDMA encoding includes the complex pseudo-noise spreading or covering and which MS-CDMA decoding includes removal of this complex pseudo-random spreading or covering and which

15 provide a means for complex orthogonal MS-CDMA encoding spreading over a frequency band with a lower chip rate than the chip rate using current CDMA encoding

provide a means for complex orthogonal MS-CDMA encoding spreading over a non-contiguous frequency band with a lower chip  
20 rate than the chip rate using current CDMA encoding

provide a means for controlling the power level of the transmitted signal as a function of the frequency over the frequency band

provide a means to implement the fast complex MS-CDMA  
25 encoding and decoding over multiple scales and which MS-CDMA includes the complex pseudo-noise spreading or covering and the removal of the complex pseudo-random spreading or covering

provide a means to partition the frequency band into independent subbands or groups of subbands and to MS-CDMA encode  
30 and spread the users over these subbands or groups of subbands.

provide a means to partition the frequency band into independent subbands or groups of subbands and assign the users to the subbands or groups of subbands and to MS-CDMA encode and spread the users within their assigned subbands or groups of  
35 subbands

provide a means to implement a 2 scale MS-CDMA to assign the users to subband groups and to MS-CDMA encode and spread each set of users in these groups such that each user in the group is spread over all of the subbands in the group in a scale 1  
5 encoding and spreading and is spread within each subband of the group in a scale 0 encoding and spreading and provide a means for implementing fast encoding and decoding algorithms

provide a means a means to implement a 2 scale MS-CDMA to assign the subbands over a frequency band into MS-CDMA groups and  
10 to MS-CDMA encode and spread each user in a group such that each user is spread within each subband in the MS-CDMA group in a scale 0 encoding and spreading and is spread over the subbands of the MS-CDMA group in a scale 1 encoding and spreading and provide a means for implementing fast encoding and decoding algorithms

15 provide a means to exploit the separability of the complex orthogonal 2 scale MS-CDMA code matrix as a generalized Kronecker product of a subband complex orthogonal MS-CDMA code matrix for scale 0 encoding and spreading and a wideband complex orthogonal MS-CDMA code matrix for scale 1 encoding and spreading and  
20 provide a means for implementing fast encoding and decoding algorithms

provide a means to exploit the separability of the complex orthogonal multi-scale MS-CDMA code matrix as generalized Kronecker products of orthogonal complex MS-CDMA code matrixes  
25 for each of the MS-CDMA scales 0,1,. . . and with each scale assigned to an independent communications parameter and with each scale performing encoding and spreading of the users and to provide a means for implementing fast encoding and decoding algorithms

30 provide a means for generating a complex orthogonal multi-scale MS-CDMA code matrix which exhibits the separability property that allows the MS-CDMA code matrix to be separable into a generalized outer product of 2 or more complex orthogonal MS-CDMA code matrices for encoding spreading at each of the scales  
35 and with each scale assigned to an independent communications

parameter and with each scale performing encoding and spreading of the users and to provide a means for implementing fast encoding and decoding algorithms

3. A means for the design of new multi-scale complex code  
5 division multiple access MS-CDMA orthogonal frequency division  
multiple access OFDMA communications and a means for the design  
of new MS-CDMA orthogonal Wavelet division multiple access OWDMA  
communications and which MS-CDMA encoding includes the pseudo-  
noise complex spreading or covering and which MS-CDMA decoding  
10 includes removal of this pseudo-random complex covering or  
spreading and which

provide a means for MS-CDMA encoding and spreading of the  
users over the OFDMA or OWDMA channels in a frequency band which  
may be non-contiguous

15 provide a means for MS-CDMA encoding and spreading of the  
users in the OFDMA or OWDMA channels over a frequency band which  
may be non-contiguous

provides a means for MS-CDMA encoding and spreading of the  
users within each of the OFDMA or OWDMA channels and over all of  
20 the OFDMA or OWDMA channels such that each user is in each of the  
OFDMA or OWDMA channels

provide a means for implementing fast encoding and decoding  
algorithms for the complex MS-CDMA

provide a means for implementing fast algorithms for the  
25 multi-resolution complex Wavelet transform for OWDMA encoding and  
a means for implementing fast algorithms for the multi-resolution  
complex Wavelet transforms for OWDMA decoding

provide a means to implement a 2 scale MS-CDMA OFDMA or MS-  
CDMA OWDMA to assign the users to channel groups and to MS-CDMA  
30 encode and spread each set of users in these groups such that  
each user in the group is spread over all of the channels in the  
group in a scale 1 encoding and spreading and is spread within  
each channel of the group in a scale 0 encoding and spreading and  
provide a means for implementing fast encoding and decoding  
35 algorithms

provide a means for generating a complex orthogonal multi-scale MS-CDMA code matrix which exhibits the separability property that allows the MS-CDMA code matrix to be separable into a generalized outer product of 2 or more complex orthogonal MS-  
5 CDMA code matrices for encoding spreading at each of the scales and with each scale assigned to an independent communications parameter and with each scale performing encoding and spreading of the users and with one or more scales assigned to OFDMA or OWDNA

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